Armed Forces College of Medicine

AFCM

Spinal Cord

Ass. Prof. Dr. Walaa Baher

INTENDED LEARNING OBJECTIVES (ILO)

By the end of this lecture the student will be able to:

1- Describe the internal structure of spinal cord

2- **Correlate the different lamination of gray matter to their nuclear content**

3- Differentiate between the different levels of spinal cord

Lecture Plan

1. ***Part 1 (5 min)*** Introduction to the spinal cord

2. ***Part 2 (35 min)*** Main lecture:
- General topography
- Spinal cord structure
- Spinal cord nuclei
- Lamination of spinal cord
- Spinal cord levels

3.Part 3 (5 min) Summary

4. Lecture Quiz (5 min)

Nervous system

Central nervous system

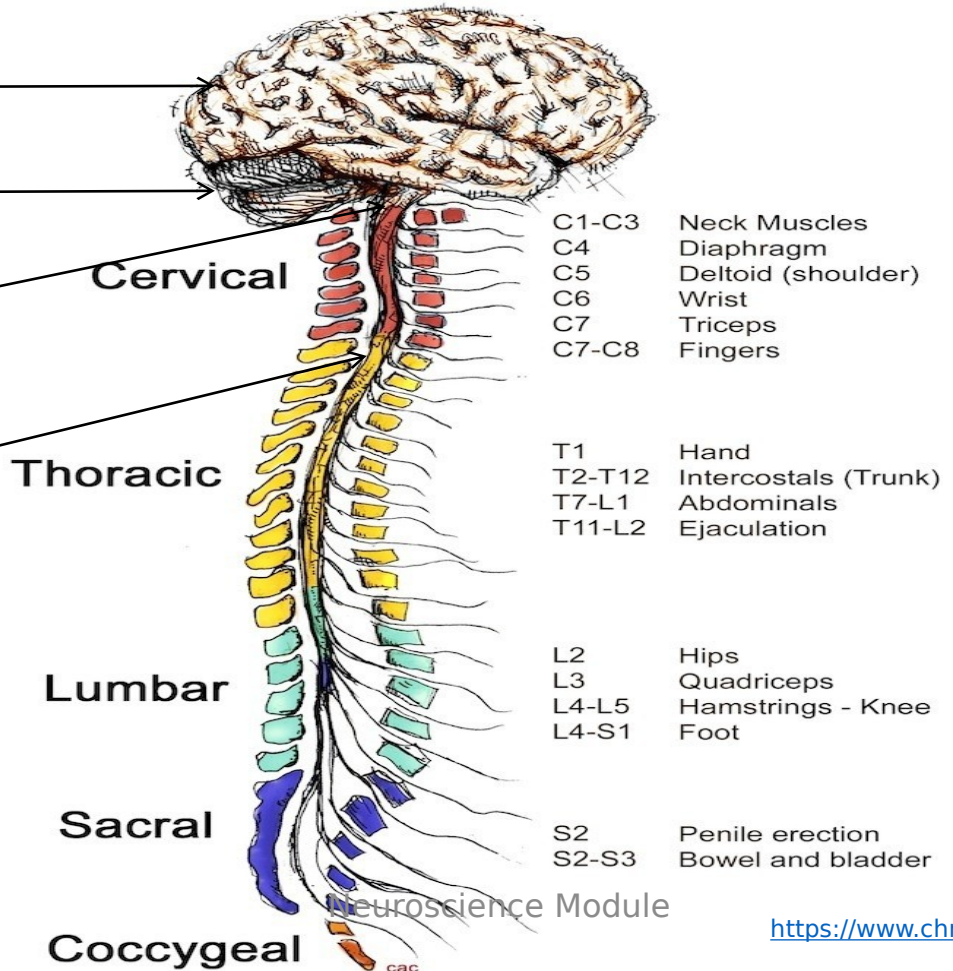
Peripheral nervous system

Cerebrum

Cerebellum

Brain stem

Spinal Cord



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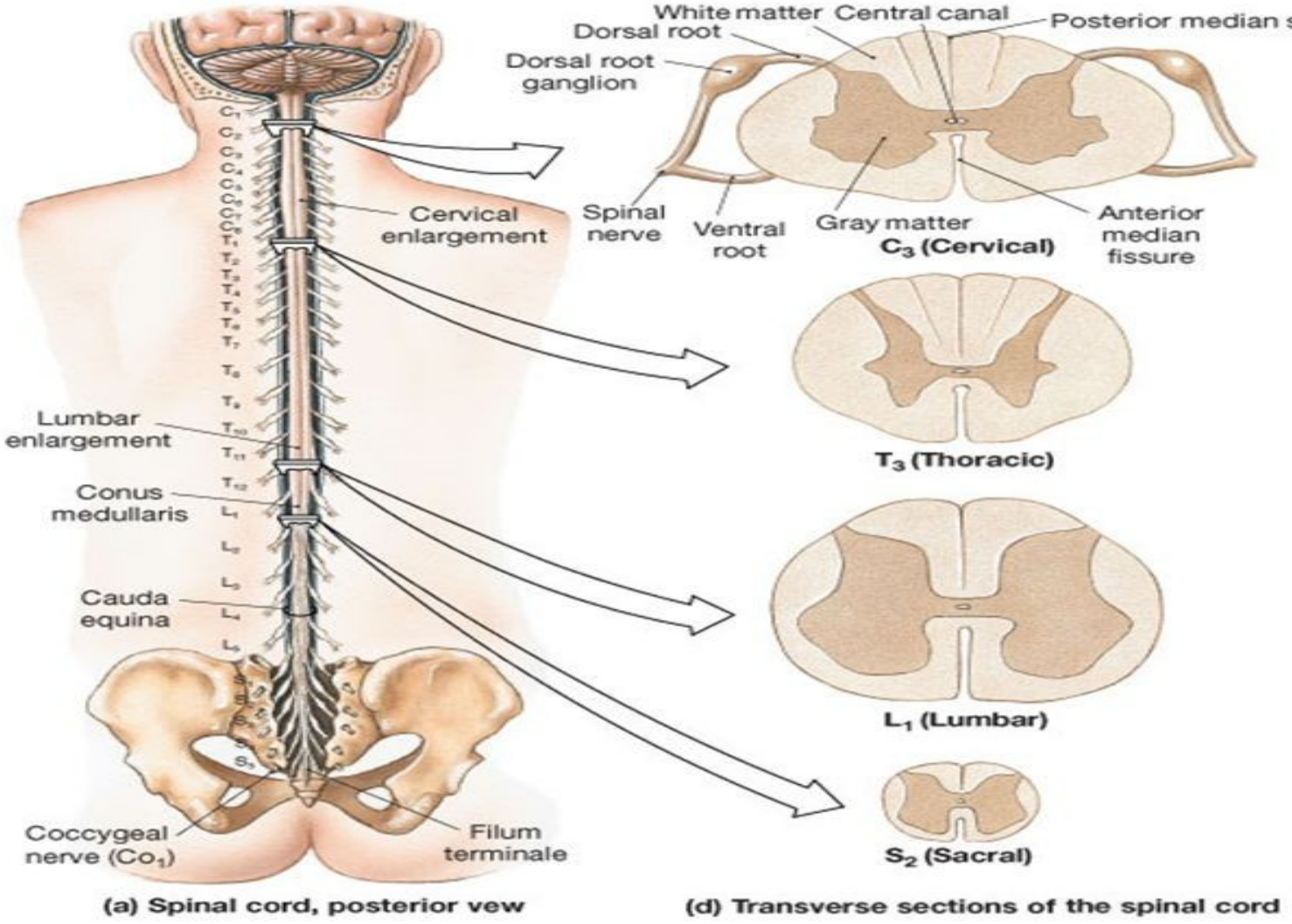
Spinal cord



white matter = columns

gray matter = horns

31 pairs of Spinal Nerves

8 Cervical (C_1-C_8)

12 Thoracic (T_1-T_{12})

5 Lumbar (L_1-L_5)

5 Sacral (S_1-S_5)

1 Coccygeal (Co_1)

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General topography of the spinal cord

2 symmetrical halves

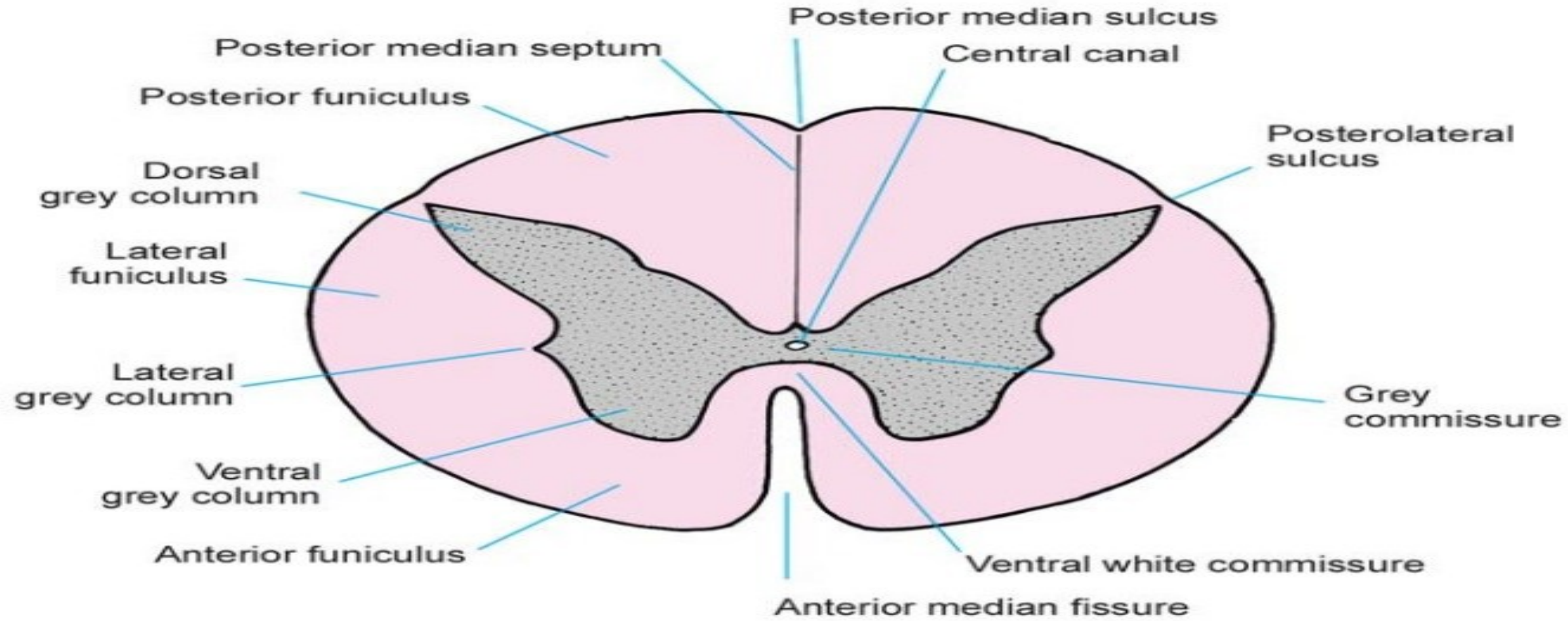

Fig. 2.1. Main features to be seen in a transverse section through the spinal cord.

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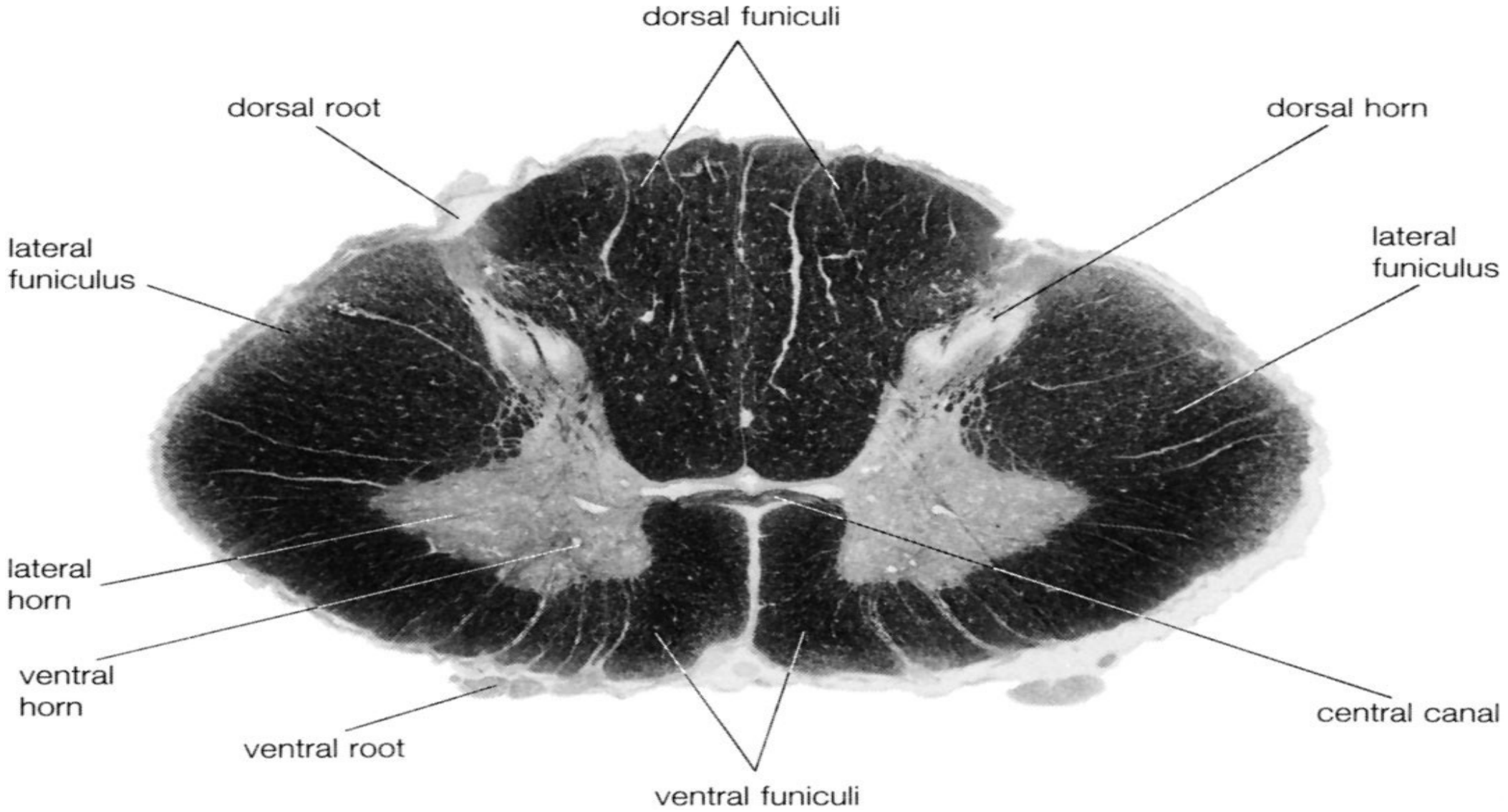
General topography of the spinal cord



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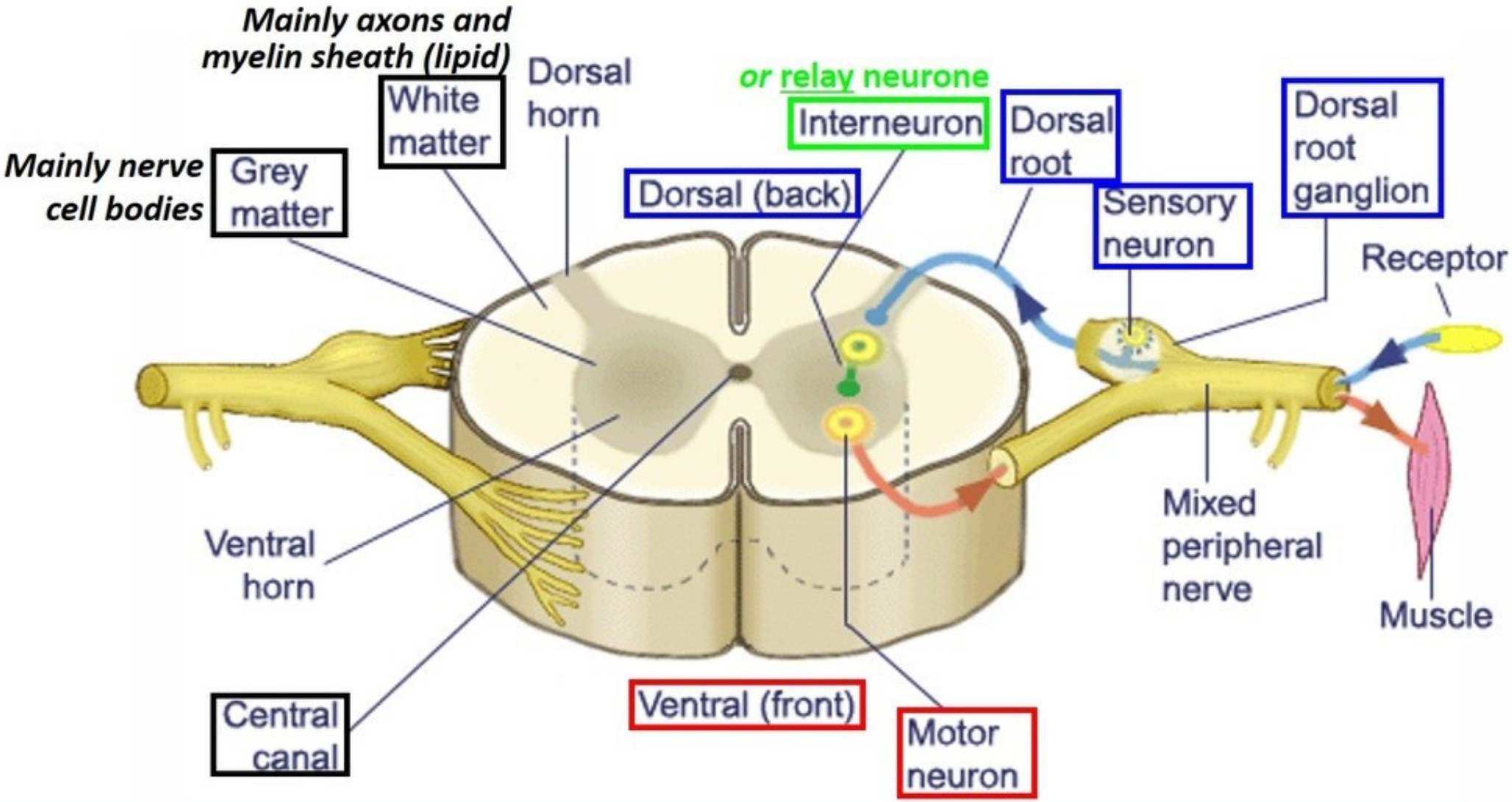
drawing.jpg

The Spinal Cord: structure



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Spinal cord structure

Gray matter

Central

- **Nerve cells**
- **Unmyelinated nerve fibers**
- **Neuroglia**
- Blood vessels

White matter

Peripheral

- **Myelinated nerve fiber**
- **Neuroglia**
- Blood vessels

White matter:

1- **Anterior white column**

2- **Lateral white column**

Spinal cord gray matter

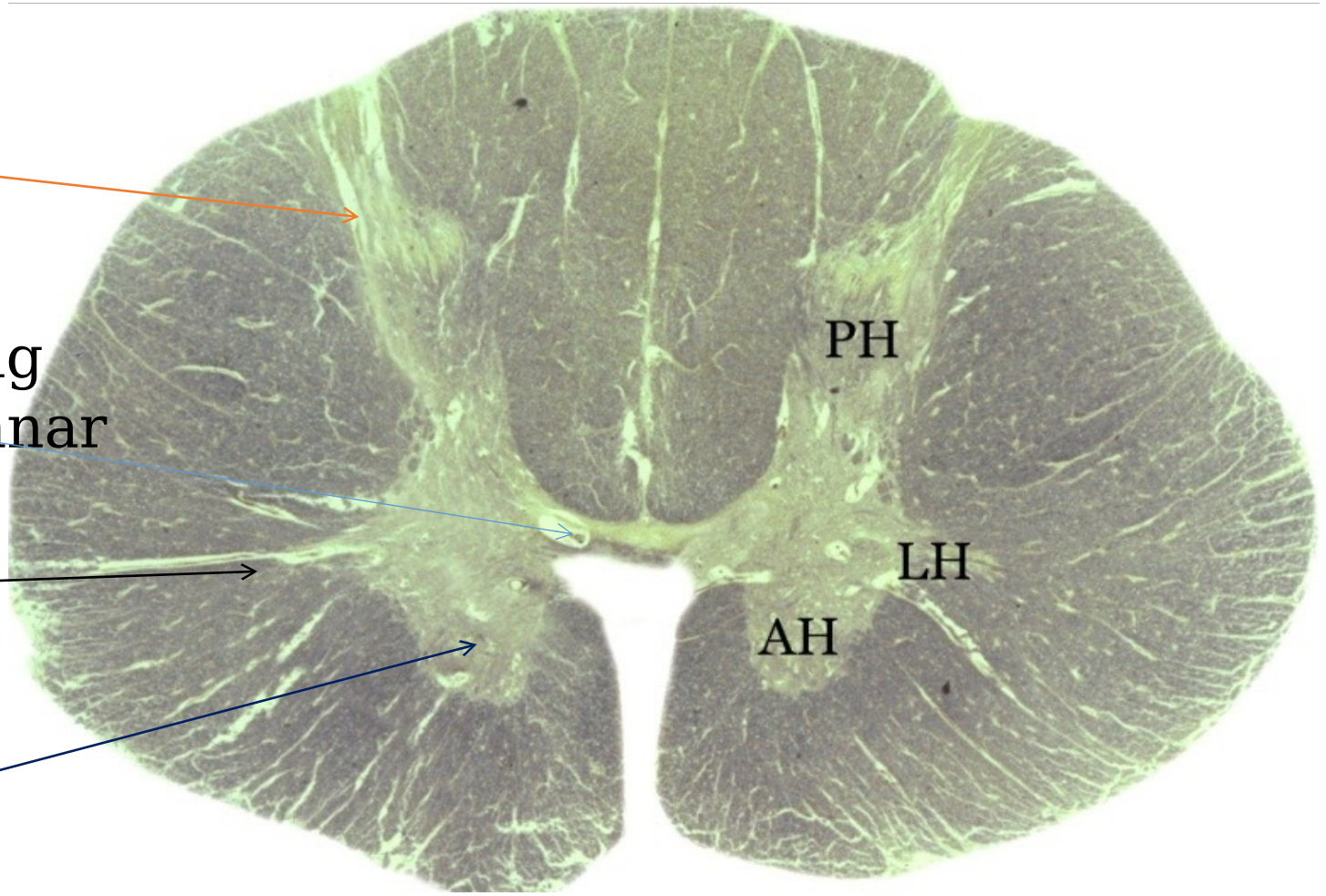
Spinal cord gray matter

Posterior horns (sensory nuclei)

Gray commissure containing **central canal** lined by columnar ependymal cells

small lateral horn (T1-L3)

Anterior horns (motor nuclei)



Nuclei in gray matter: 1) Dorsal gray column (*sensory nuclei*)

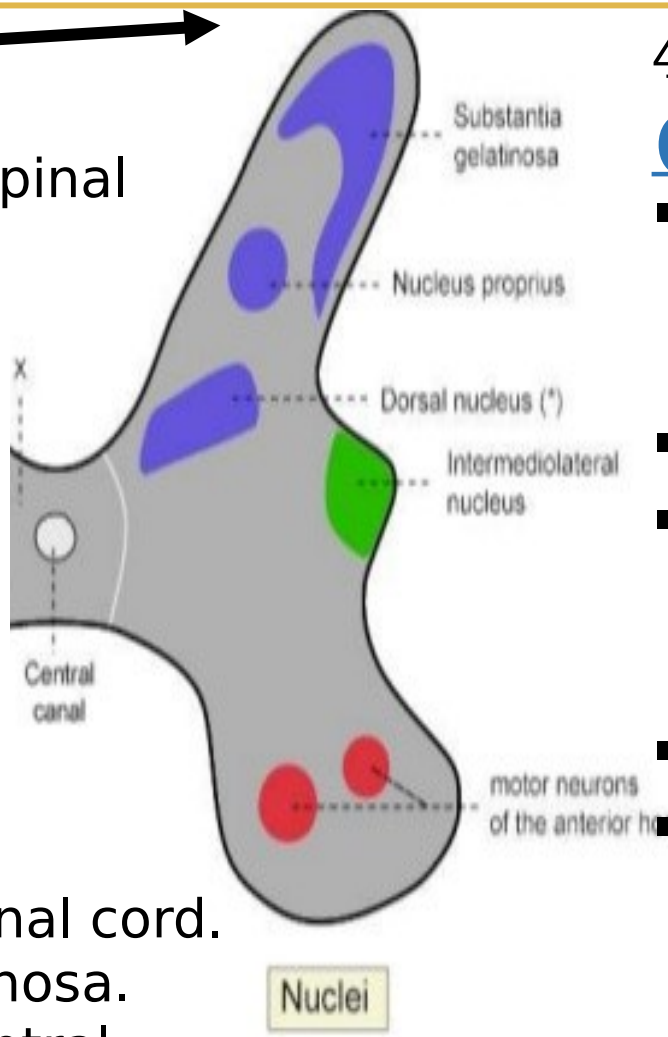
1) Dorsomarginal nucleus

- Capping the dorsal horn
- Extends the entire length of the spinal cord

2) Substantia gelatinosa of Rolandi:

-Extends the entire length of the spinal cord.

-Formed of ***Golgi type II neurons***, that possess highly branched, unmyelinated axons.



3) Nucleus proprius dorsalis (main sensory nucleus):

- Extends the entire length of the spinal cord.
- Just ventral to the substantia gelatinosa.
- Provides input to the lateral and ventral spinothalamic tracts.

4) Clark's nucleus (Nucleus dorsalis):

- Intermediate zone of the spinal cord (base of post. Horn)
- Extends from C8-L3
- Large multipolar cells with prominent Nissl granules
- Eccentric nucleus.
- Gives DSC tract

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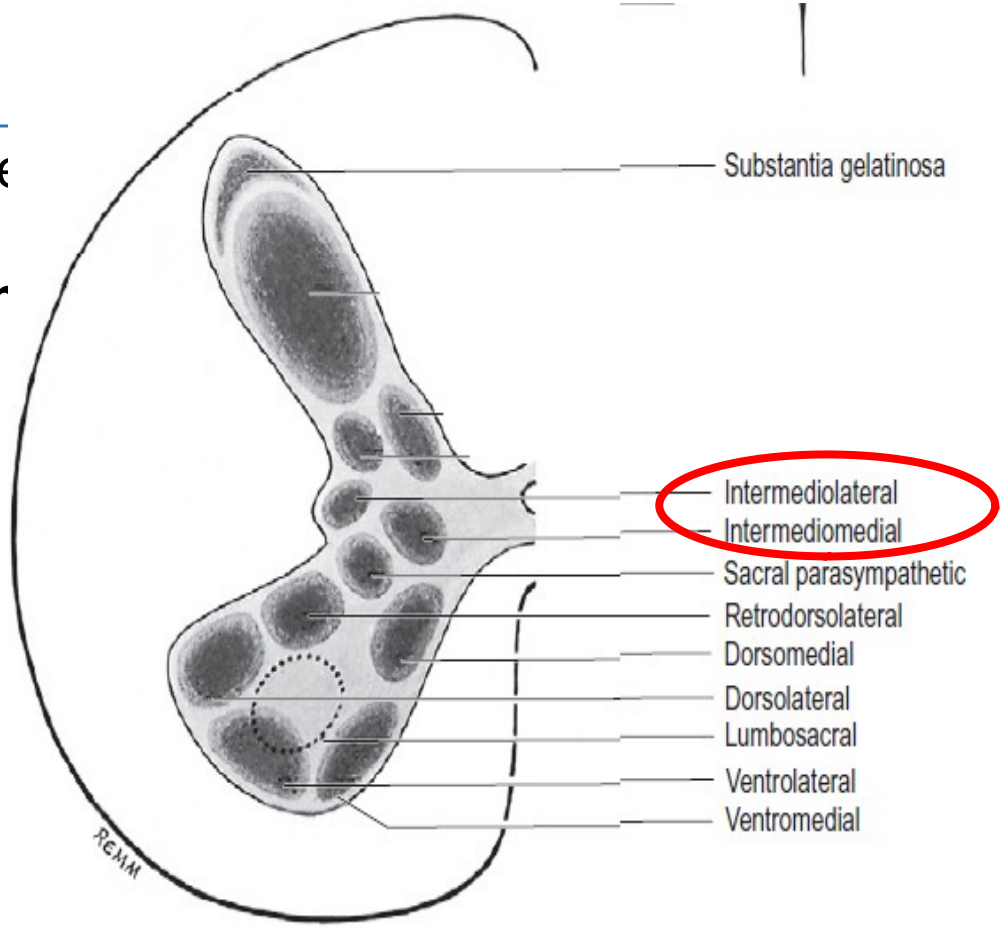
Nuclei in gray matter: 2) Lateral gray column

The intermediolateral nucleus:

- Composed of small multipolar cell bodie
- **Between T1 and L2, 3:**
  Preganglionic sympathetic neuror
- Sacral levels S2–S4:
  Sacral parasympathetic nucleus

Embryologically, they developed dorsolateral to the central canal and migrate laterally, forming ***intermediomedial*** and ***intermediolateral*** cell columns



Nuclei in gray matter: 3) Ventral gray column (*motor nuclei*)

Medial group

- Extends almost the entire length of the spinal cord.
- Between T1 and L4 it is subdivided into two components, the ***dorsomedial*** and ***ventromedial*** groups.
- Provide innervation for the skeletal muscles of the abdomen, the intercostal muscles, and the muscles of the trunk

Central group

- Present only in the cervical and lumbosacral segments of the spinal cord.
- In the cervical region, there are:

- ***Phrenic nucleus*** (C3 to C6)
- ***Accessory nucleus*** (C1 to C6).

- In the lumbosacral region:

- ***Lumbosacral group*** (L2 to S2

Lateral group

- Present only in the regions of the spinal cord responsible for the motor innervation of the upper and lower extremities (C4–T1 and L2–S3).

Subdivided into:

- ***Ventral group,***
- ***Dorsal group***
- ***Retrodorsal group***

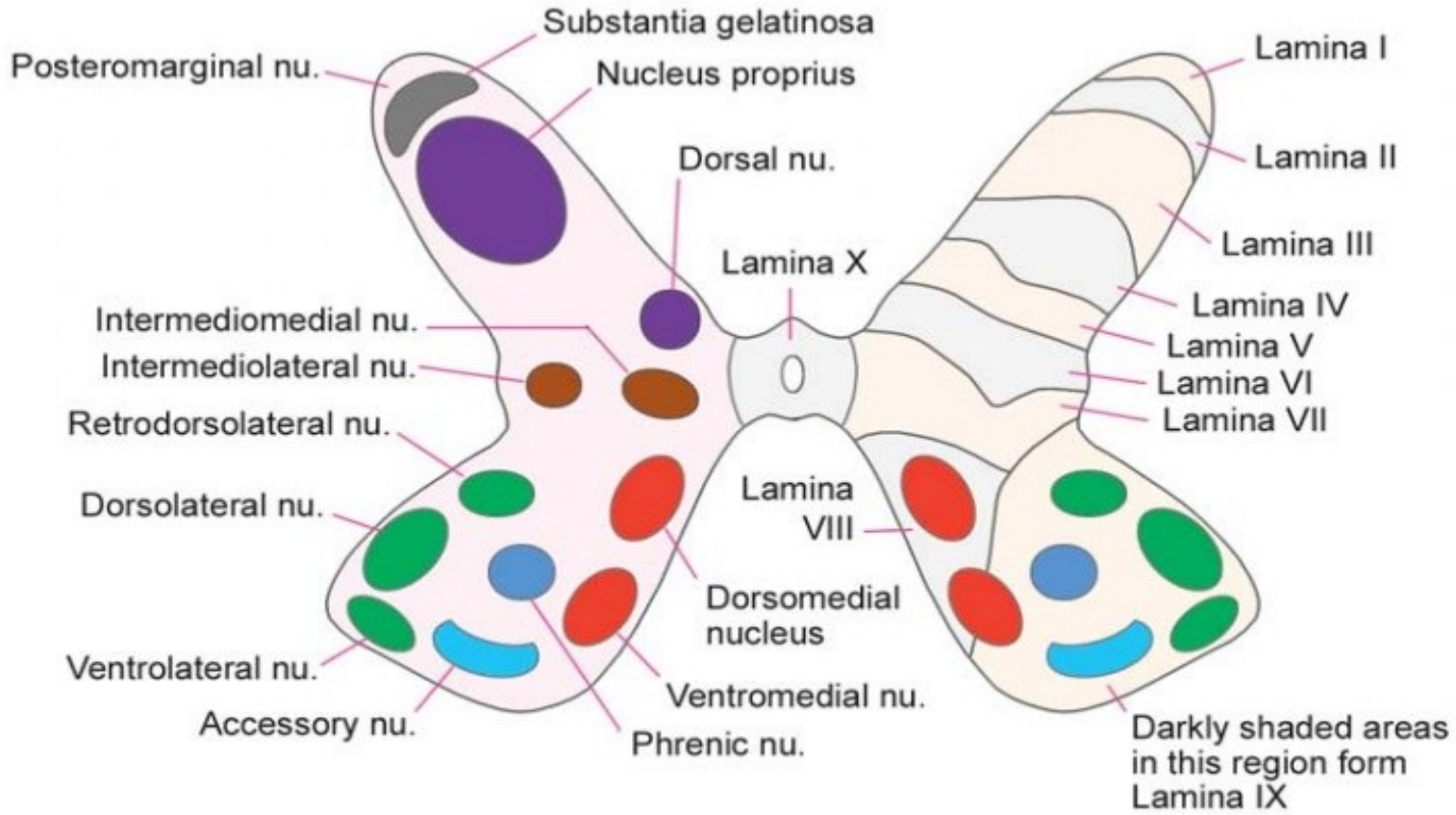


Fig. 5.2. Subdivisions of the grey matter of the spinal cord. The left half of the figure shows the cell groups usually described. The right half shows the newer concept of laminae.

http://www.brainkart.com/media/article/article-Grey-Matter-of-the-S-fVt.jpg

Motor nuclei in anterior horn cells

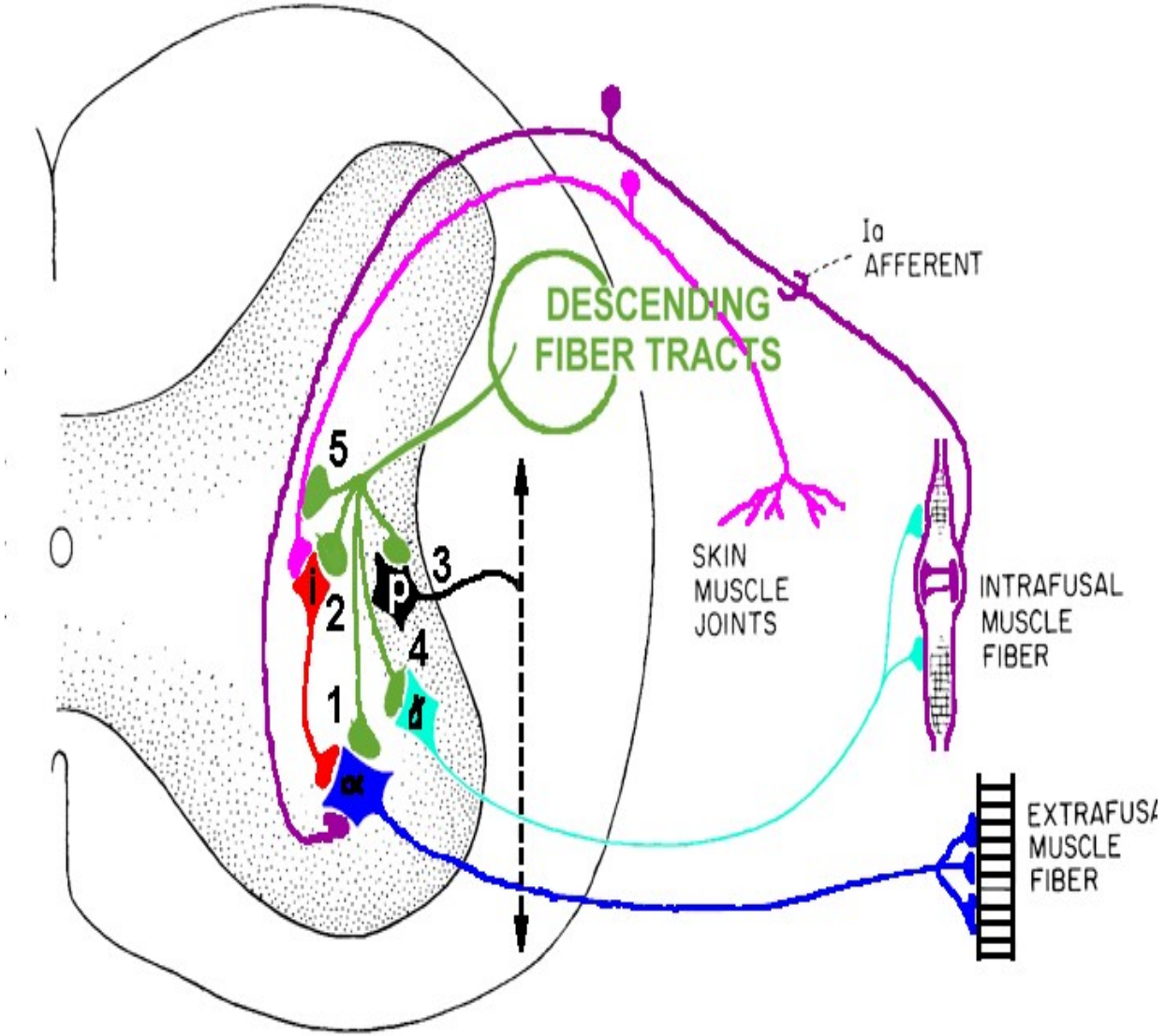
1-Alpha α neurons:

-**Large** cells

- Multipolar

-Prominent Nissil granules.

-Their axons (**α** efferents) leave the spinal cord through the ventral roots and innervate skeletal muscle.



2- Gamma γ neurons:

-smaller cells.

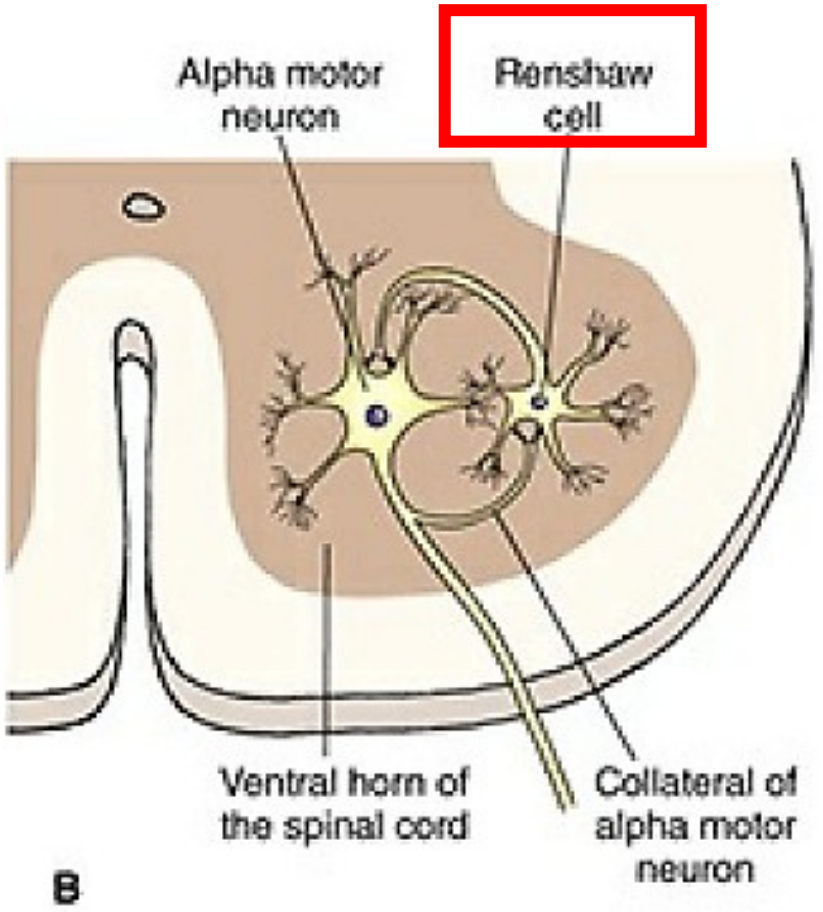
-Their axons (**γ** efferents) supply **intrafusa**l muscle fibers of

https://www.d.umn.edu/~jfitzake/Lectures/DMED/MotorControl/SupraspinalControl/SupraspinalControl.html

Motor nuclei in anterior horn cells

<u>Renshaw cells:</u>
Interneurons that are inhibitory to α motor neurons

In **<u>tetanus</u>,** Renshaw cells are damaged **spasm, lock jaw.**



Lamination of Spinal cord

Rexed’s laminae of spinal cord

Lamina I:

a cap of the posterior horn
corresponds to **posteromarginal** nucleus

Lamina II:

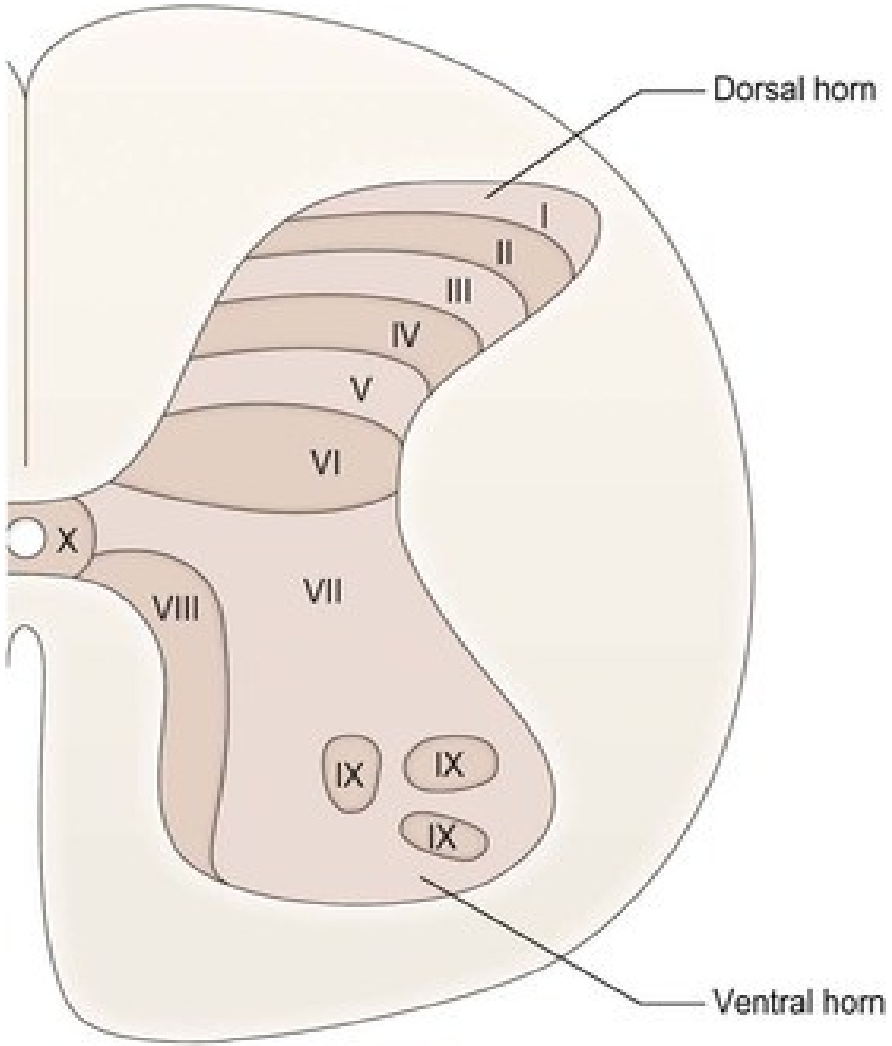
a fairly broad band around the apex of posterior horn
corresponds to **substantia gelatin**osa.

Lamina III:

band across the posterior horn and is parallel to lamina I and II

Lamina IV:

the thickest lamina extending across the posterior horn



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Laminae III and IV correspond to main sensory nucleus

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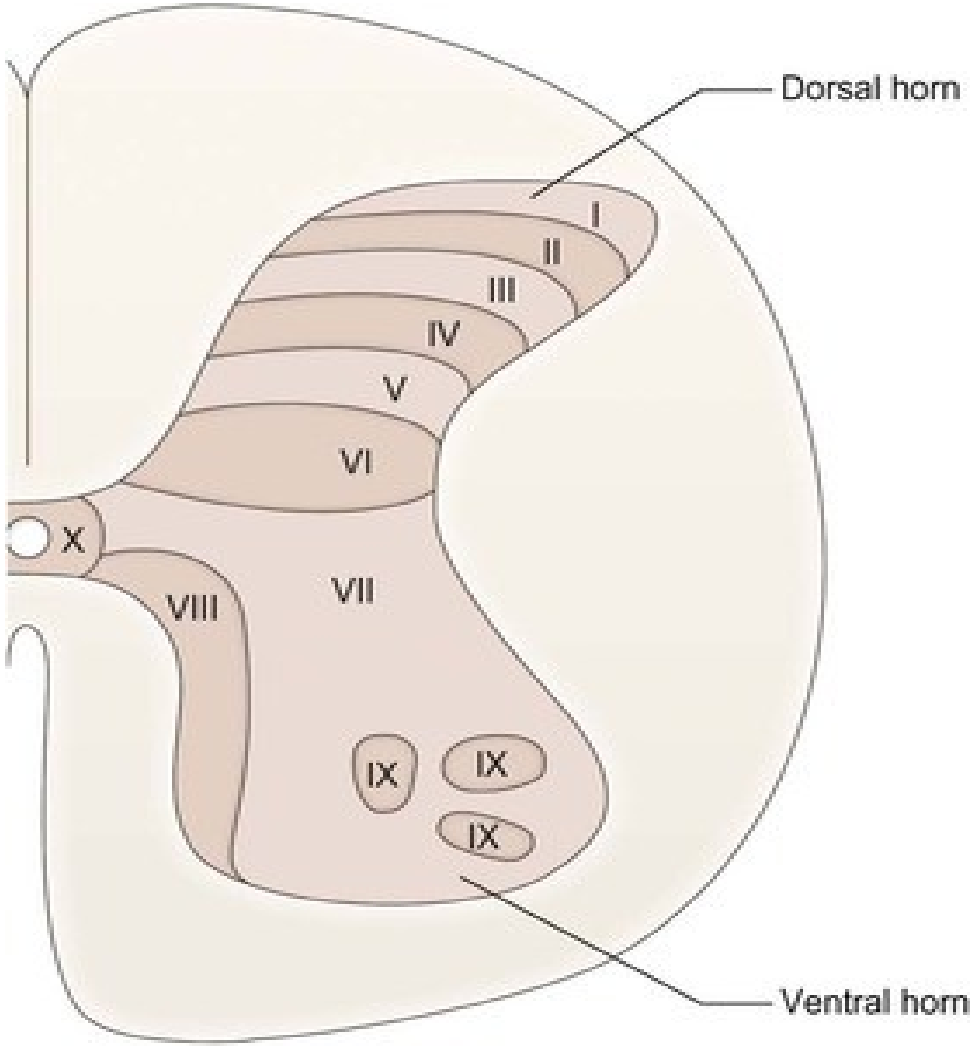
Rexed's laminae of spinal cord

Lamina V:

- **neck** of the dorsal gray column
- Houses thick bundles of nerve fibers
- Its lateral aspect is referred to as the ***formation reticularis.***

Lamina VI:

- Corresponds to the base of the dorsal horn.
- Prominent in the limb enlargements.
- Medial part contains of small, densely packed neurons while, the lateral part contains larger, more loosely packed neurons.



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Rexed’s laminae of spinal cord

Lamina VII:

Intermediate gray includes:

1**) Clarke’s nucleus**

2) **Intermedio-medial** nucleus

3) **Intermedio-lateral** nucleus: in the **latera**l horn in **T1 – L2**.

Laminal VIII

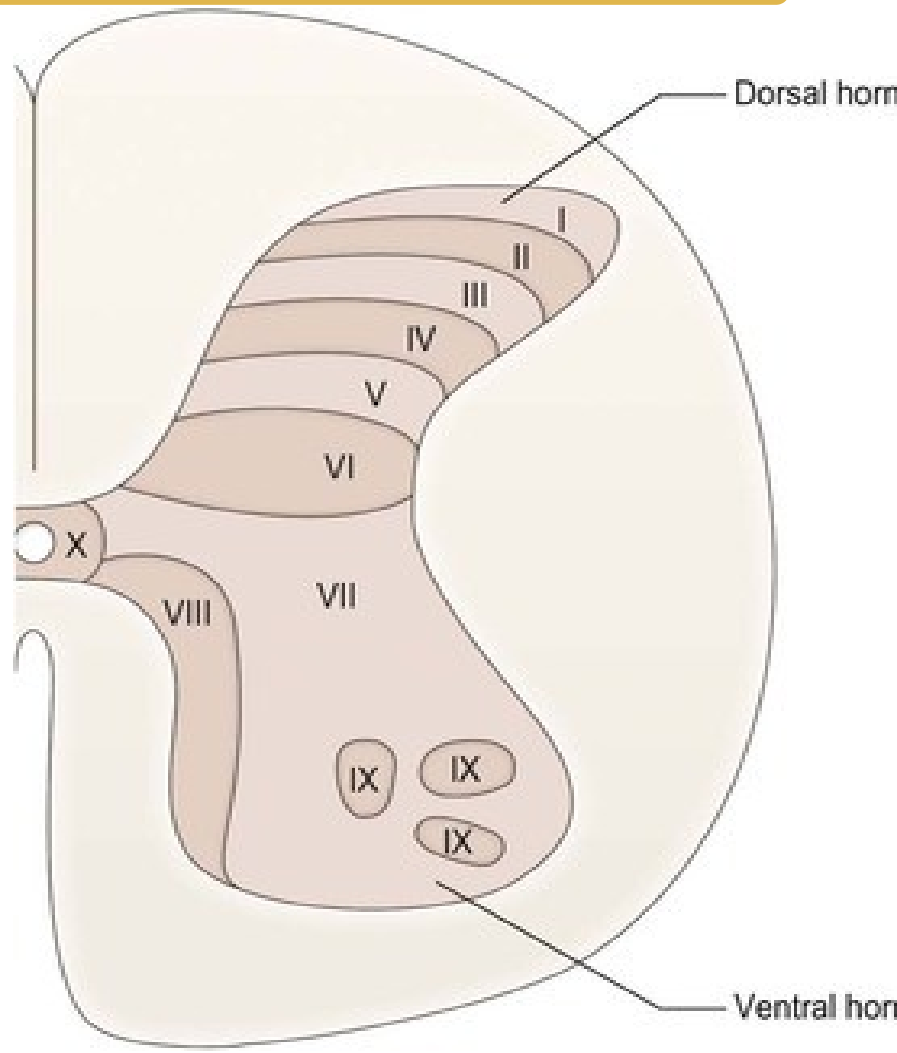
Starts at base of anterior horn, varies in size in different levels.

Lamina IX:

Motor nuclei (α and γ motor neurons

Lamina X:

forms the gray matter **aro**und the central canal.



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Lamination of gray matter

Lamina I	Postromarginal nucleus
Lamina II	Substantia gelatinosa
Lamina III	Main sensory nucleus
Lamina IV	Main sensory nucleus
Lamina V	Interneuronal neurons
Lamina VI	Interneuronal neurons
Lamina VII	Clark's,intermediomedial, intermediolateral nuclei.
Lamina VIII	Base of anterior horn
Lamina IX	M & L groups of motor nuclei
Lamina X	Grey matter around the central canal

Spinal cord white matter

Tracts of white matter

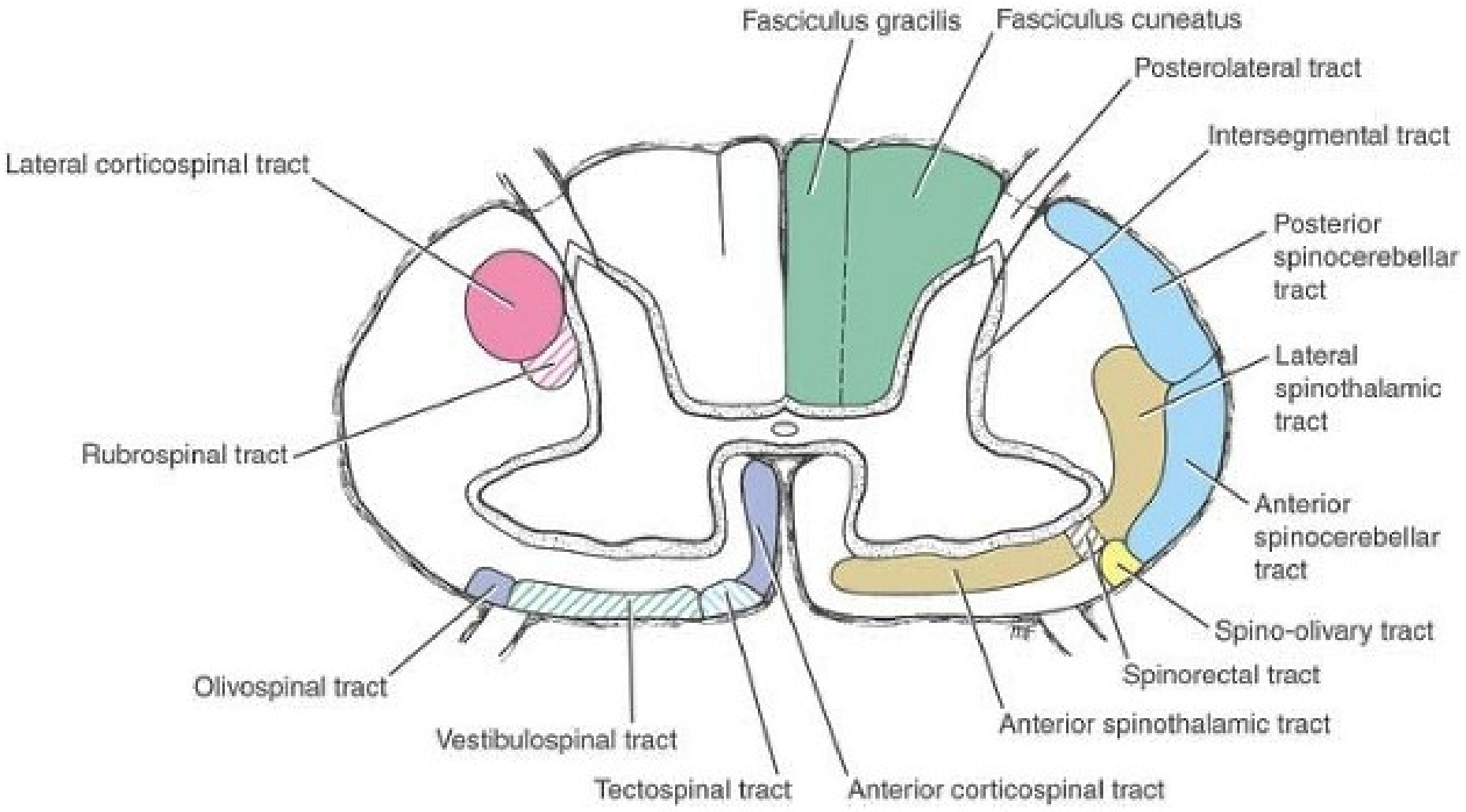
Tracts of white column are classified into three categories; *ascending*, *descending*, and *intersegmental*.

Ascending tracts: transmit sensory information to higher centers (sensory)

Descending tracts: relay motor information originating at higher centers (motor)

Intersegmental tracts: convey information between spinal cord segments coordinate intersegmental spinal reflexes

Tracts of white matter



Ascending tracts of white matter

- On entering the spinal cord, the sensory nerve fibers of different sizes and functions are segregated into tracts in the white matter.

- The ascending tracts conduct afferent information (may or may not reach consciousness).

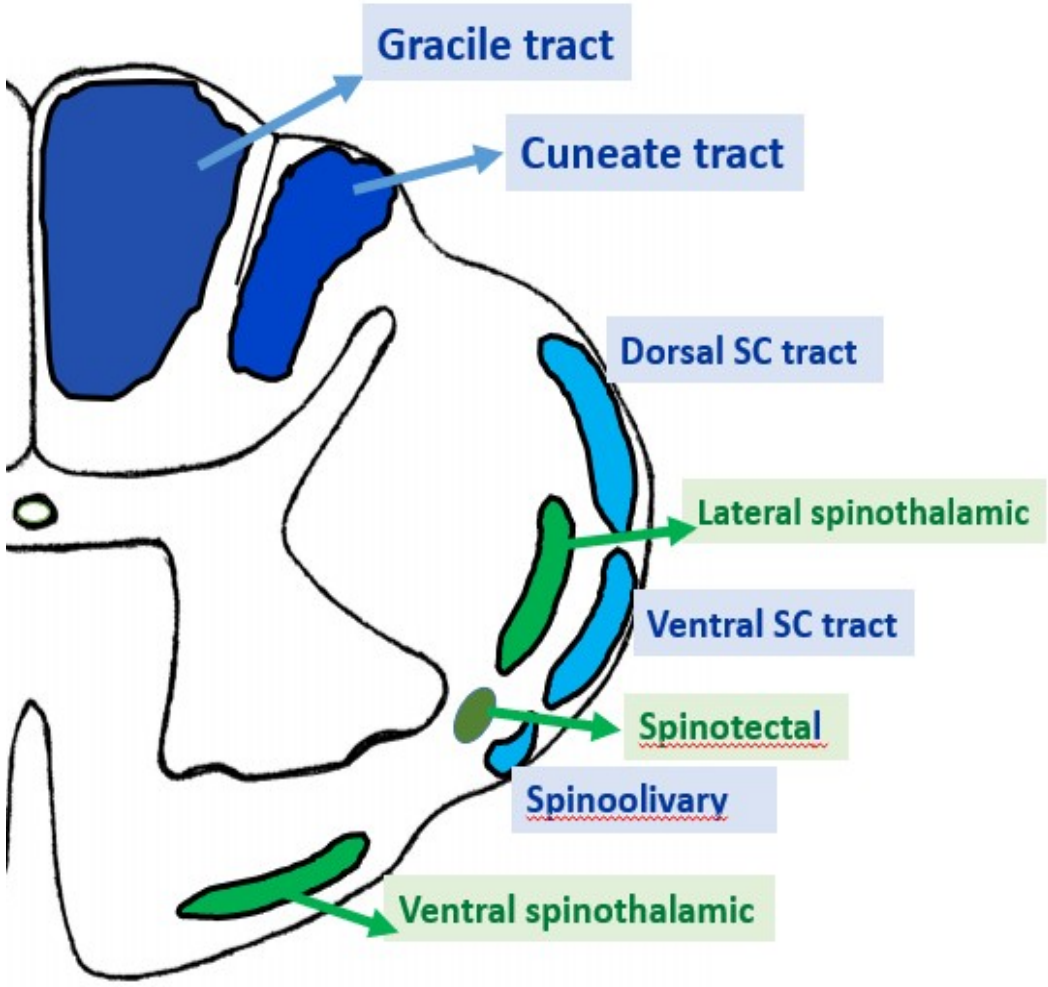
The afferent information are divided into two main groups:

(1) ***Exteroceptive information***, (originates from outside the body): pain, temperature, and touch

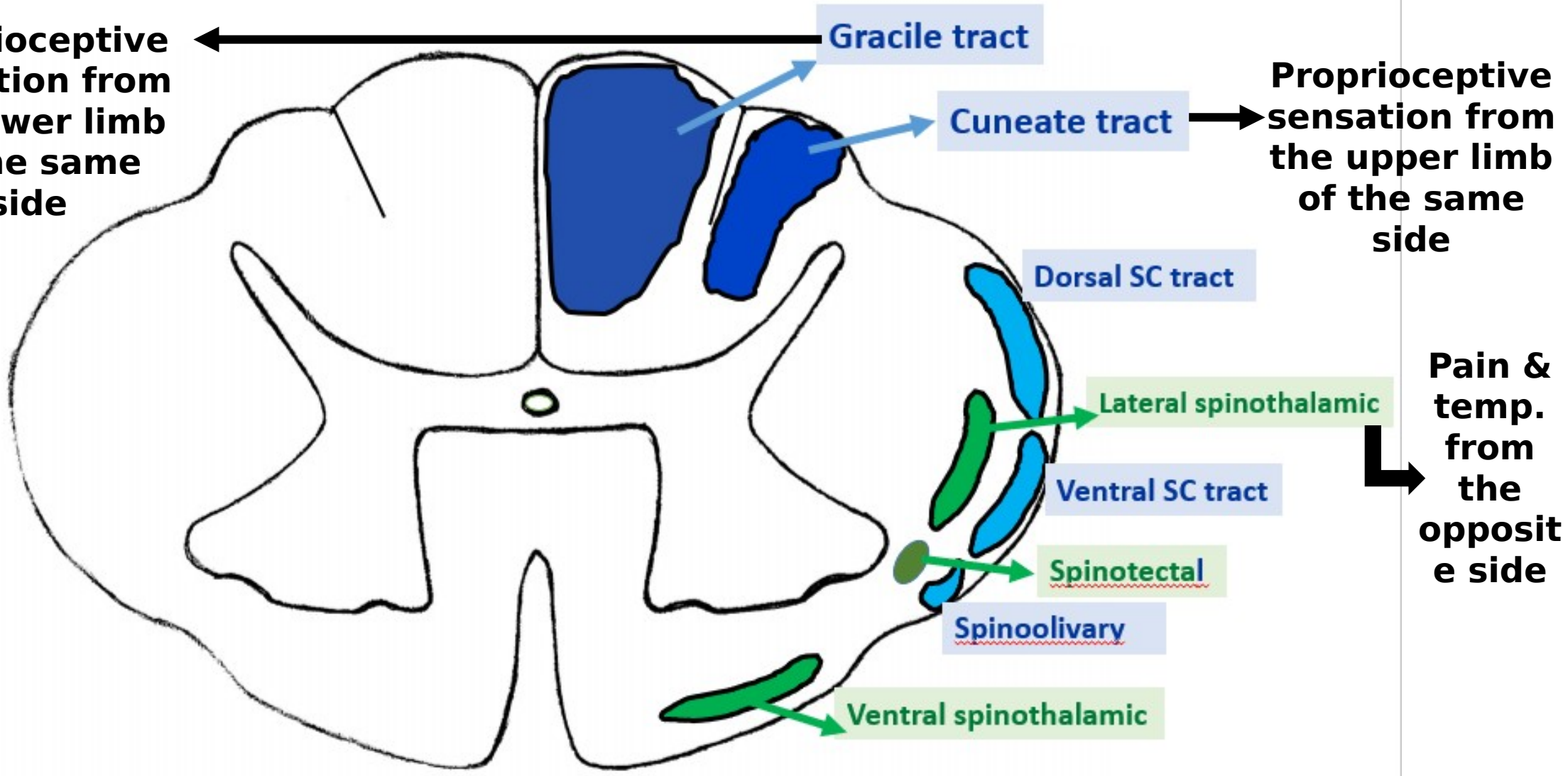
(2) ***Proprioceptive information***, (originates from inside the body): from muscles and joints.

Ascending tracts of white matter

Dorsal funiculus	Lateral funiculus	Anterior funiculus
Gracil tract	Dorsal spinocerebellar	Ventral spinothalamic
Cuneate tract	Ventral spinocerebellar	
	Lateral spinothalamic	
	Spino-tectal	
	Spino-olivary	



Ascending tracts of white matter



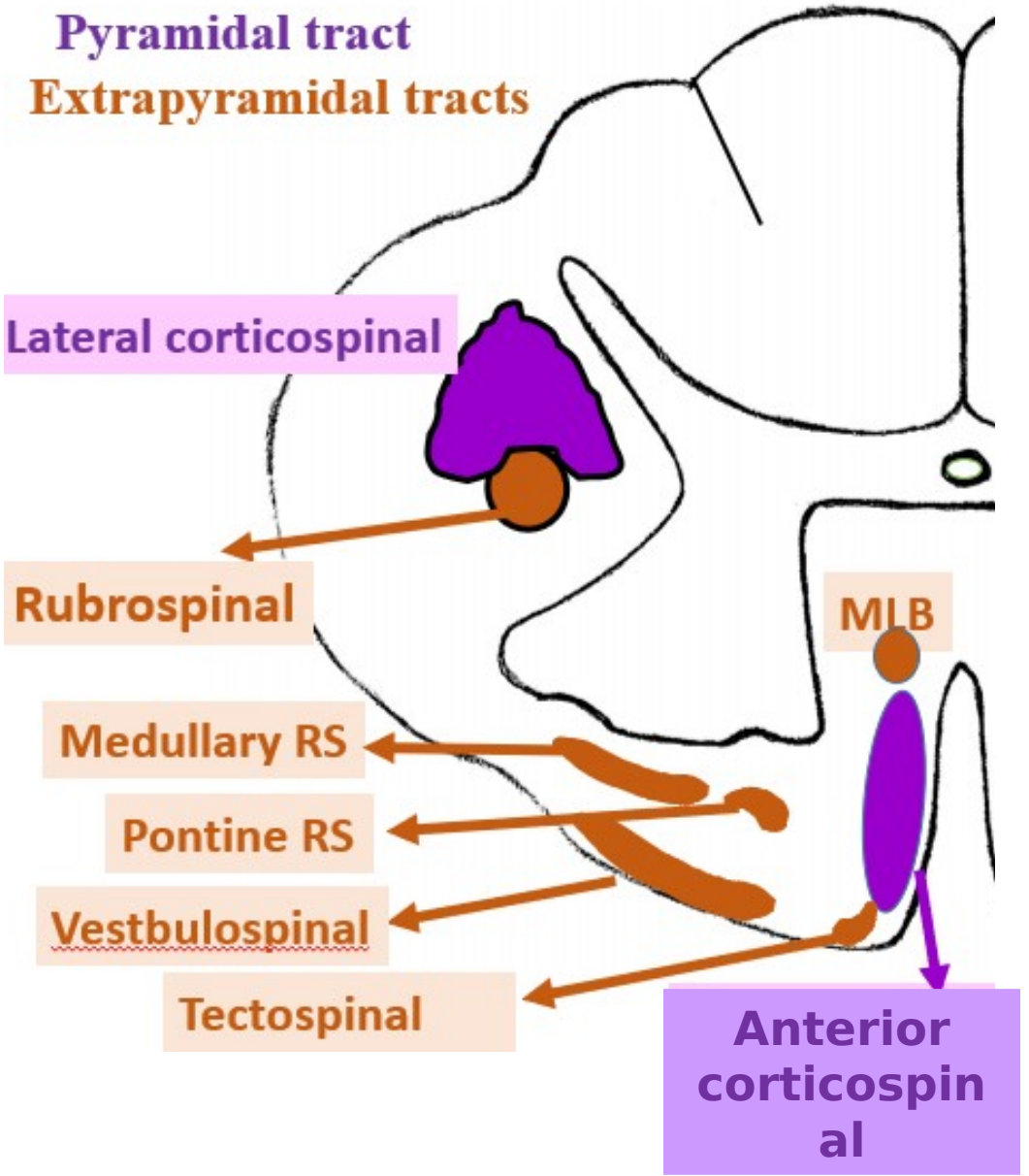
Descending tracts of white matter

- The nerve fibers that descend in the white matter from different supraspinal nerve centers are segregated into nerve bundles called the descending tracts.

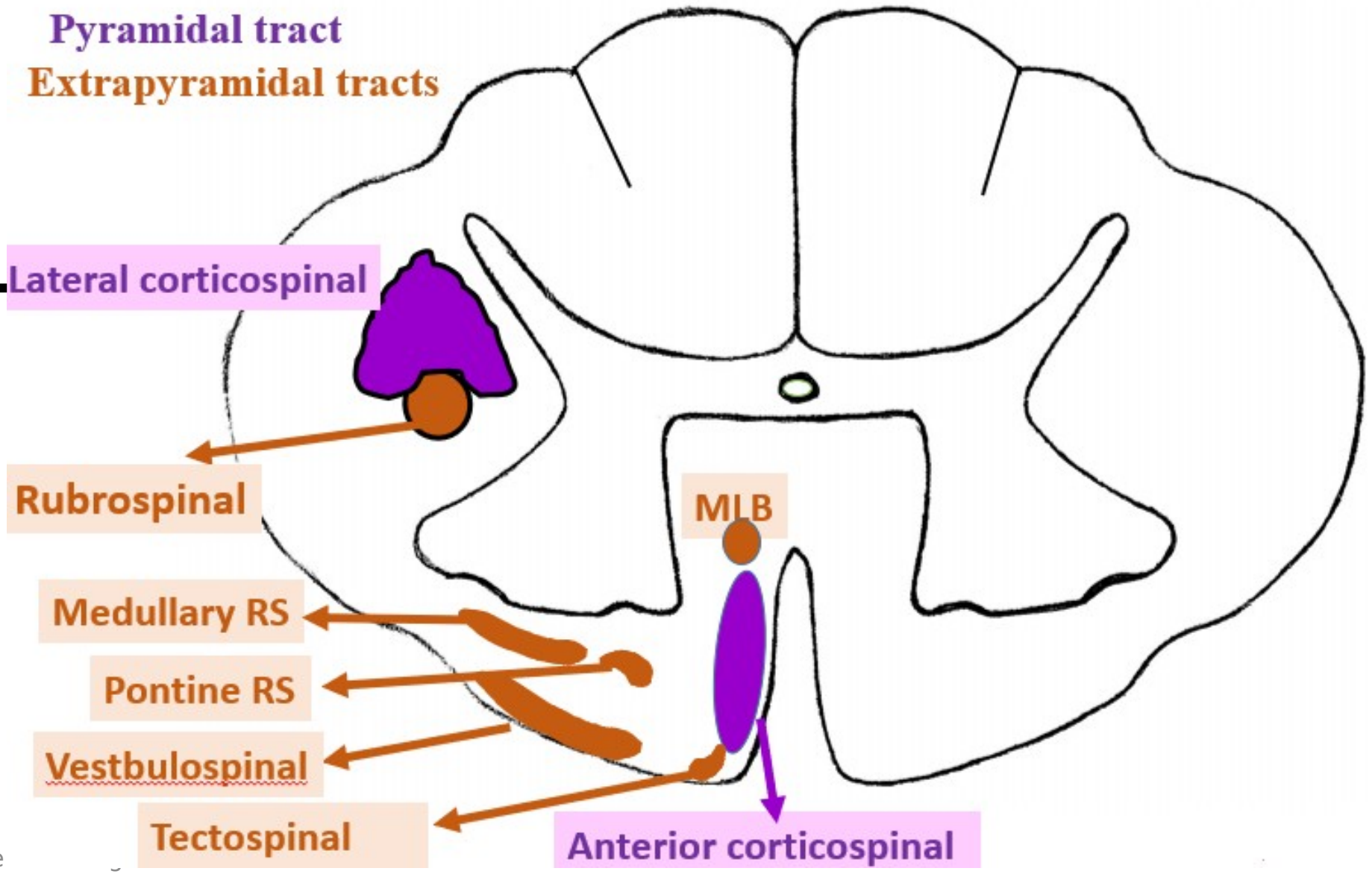
- These supraspinal neurons and their tracts are sometimes referred to as the upper motor neurons.

Descending tracts of white matter

Dorsal funiculus	Lateral funiculus	Anterior funiculus
	Lateral cortico-spinal	Ventral corticospinal
	Rubro-spinal	Vestibulospinal
	Olivo-spinal	Tectospinal
		Reticulospinal



Descending tracts of white matter



Spastic paralysis of the same side

Spinal cord levels

Spinal cord levels

Segments of the spinal cord

I- **Cervical** segments

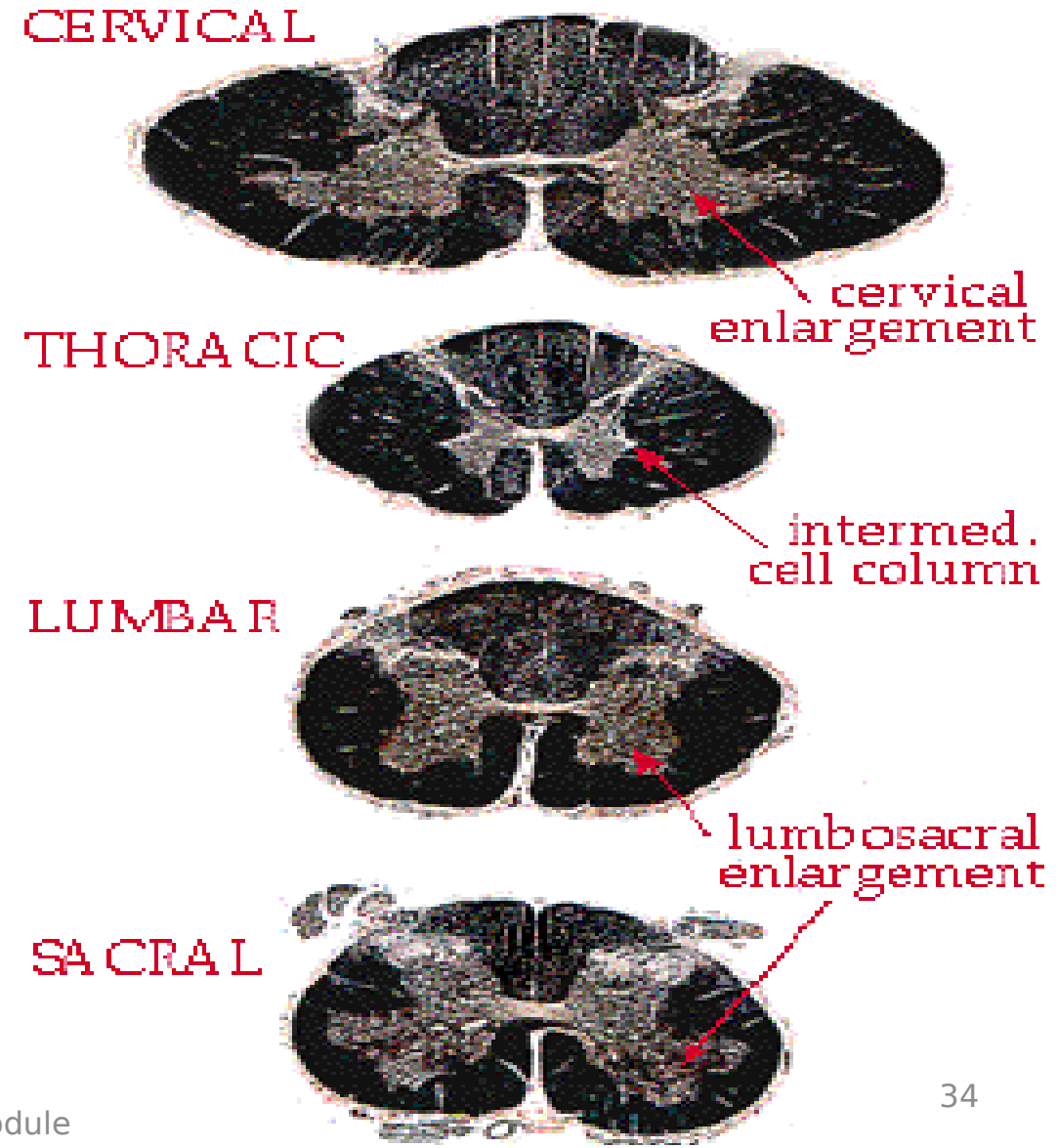
II- **Thoracic** segments including:

1- **Upper** thoracic segments and

2- **Lower** thoracic segments

III- **Lumbar** segments

IV- **Sacral** segments



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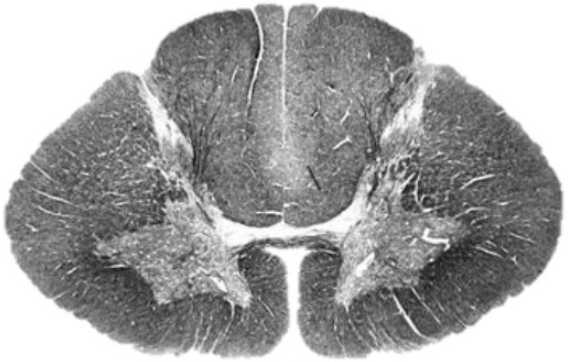
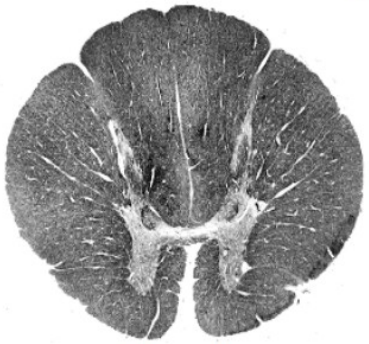
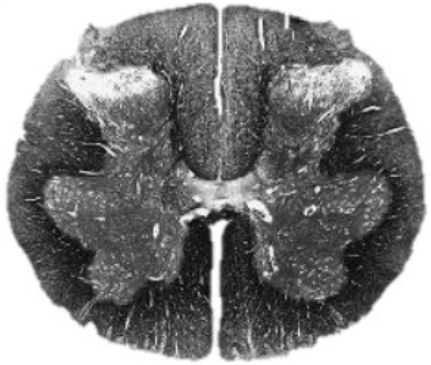
Spinal cord levels

Sacral	Lumber	Thoracic	Cervical	
Small	Large	Small	Large	**Size**
Rounded	Rounded	Rounded	Oval	**Shape**
Thick	Thick	Thin	**Thin, divergent**	**Posterior horn**
Thick	**Thick**	**Thin**	**Thick**	**Anterior horn**
No	**NO**	**Present**	**No**	**Lateral horn**
Few	Less than cervical	Less than cervical	**Greater in amount**	**White matter**


Cervical


Thoracic

Lumbar


Sacral

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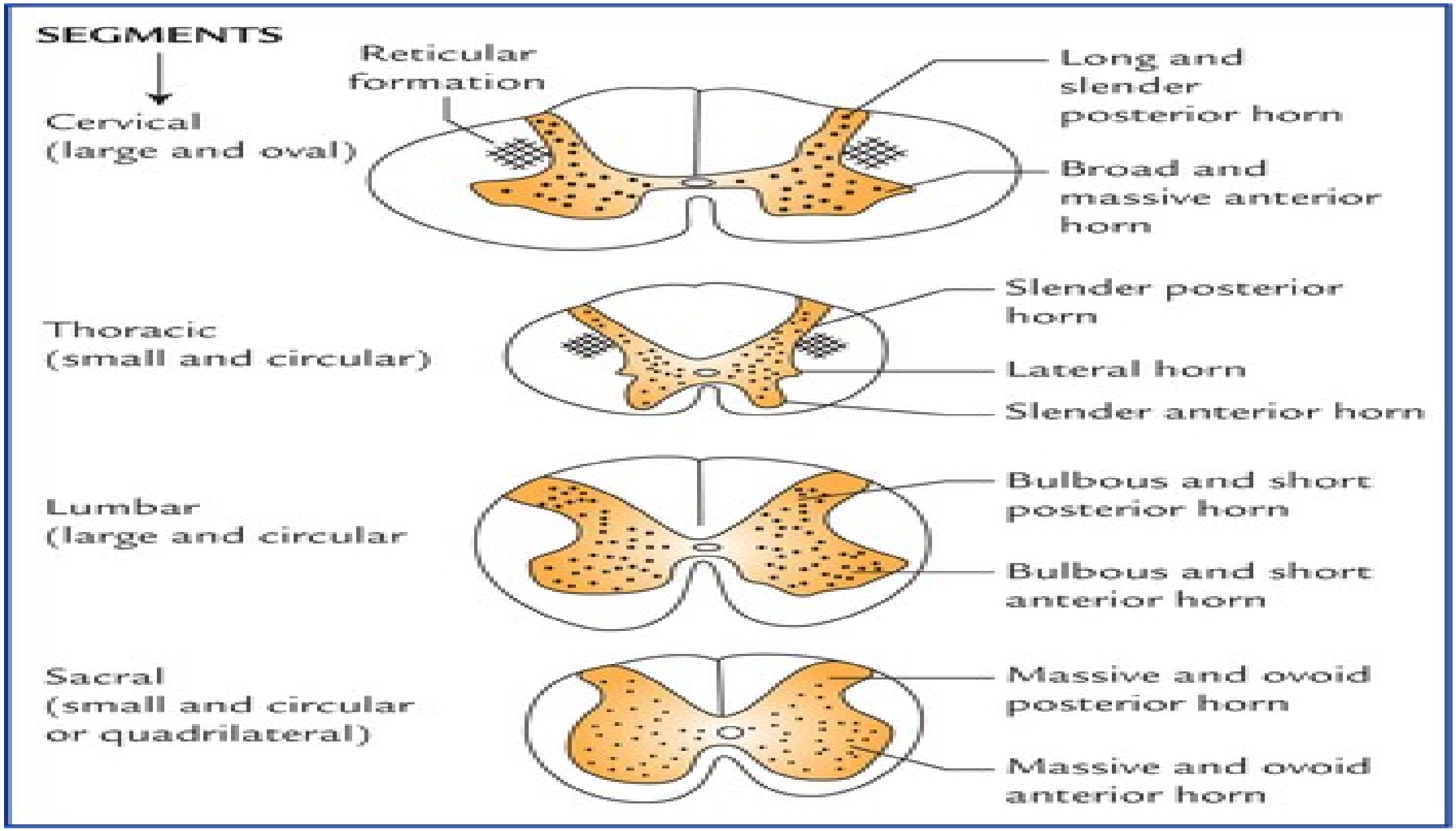

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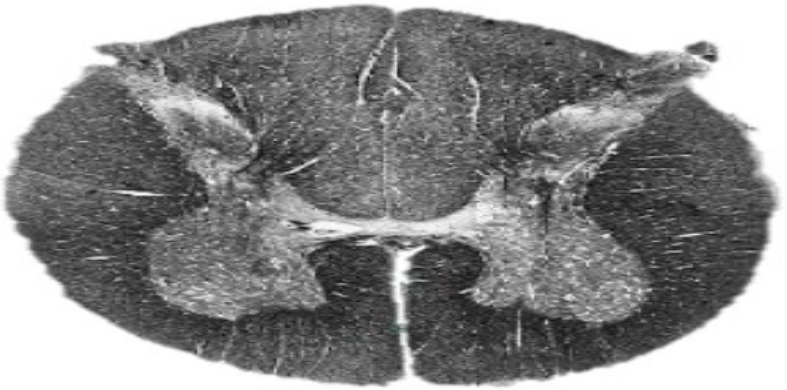
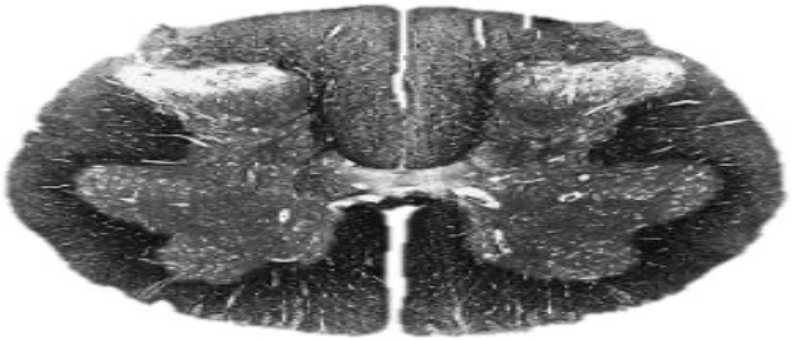
on the

Cervical

Thoracic



Lumbar



Sacral

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Quiz

Posterior gray horn of cervical levels is characterized by -1 ?which of the following

a) thick & divergent
b) thick & convergent
c) thin & divergent
d) thin & convergent

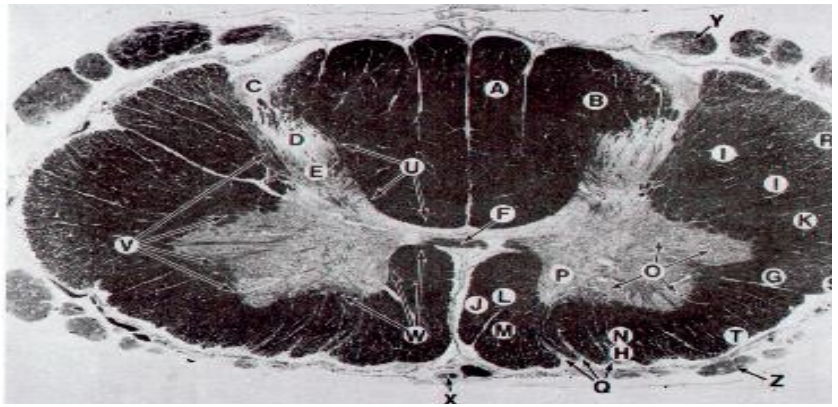
?Lamina II corresponds to which gray nuclei -2

a) Posterior marginal nucleus
b) Alpha motor nuclei
c) Main sensory nucleus
d) Substantia gelatinosa of Rolandi

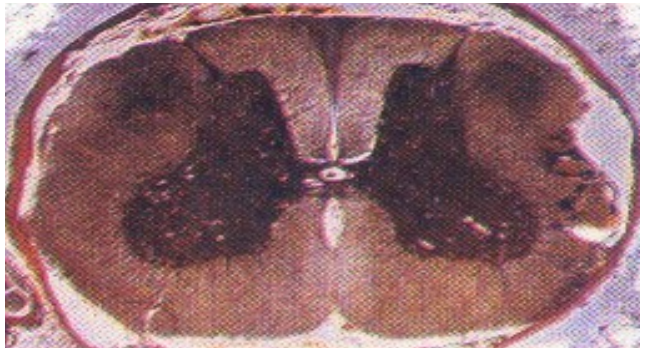
Quiz

Name the following levels

1-

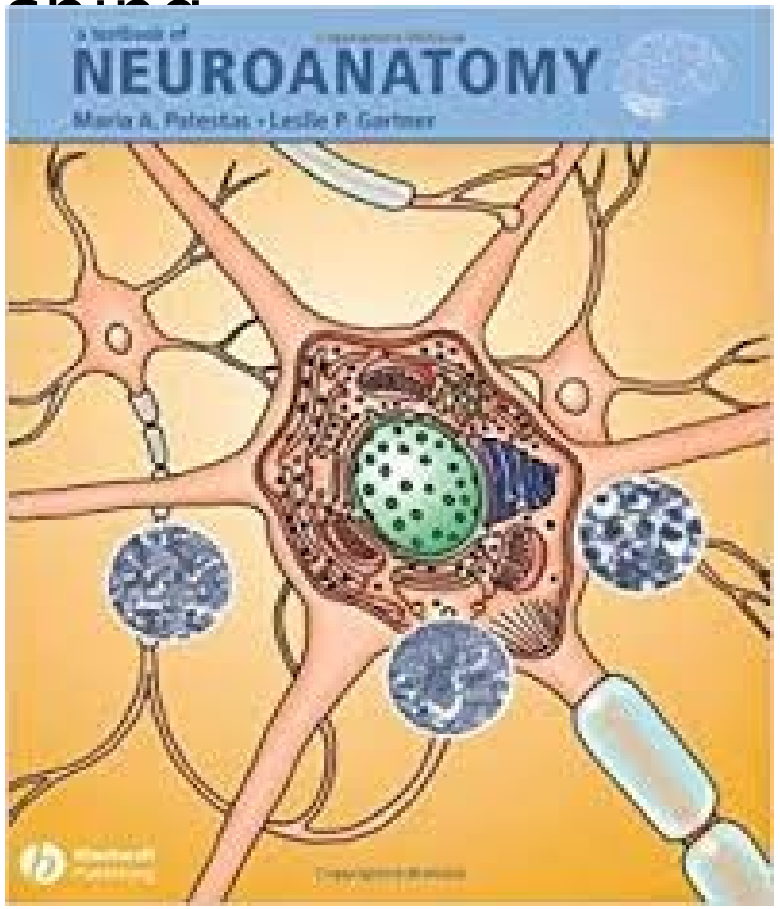


2-



Suggested text books

A Textbook of Neuroanatomy (2006): Maria A. Patestas and Leslie P. Gartner (eds). Chapter 5: Spinal cord **PP.: 50-63.** Blackwell Publishing



Thank
you